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CITATION:

TERAMATSU, Takashi ...[et al]. A New Surgical Open Treatment of the Pulmonary Tuberculous Cavities and Caseous Lesions, by Surgically Making Draining Pit. Acta tuberculosea Japonica 1952, 2(2): 55-68

ISSUE DATE:

1952-12

URL:

<http://hdl.handle.net/2433/51776>

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A New Surgical Open Treatment of the Pulmonary Tuberculous Cavities and Caseous Lesions, by Surgically Making Draining Pit

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(Received Oct. 30, 1952)

Introduction

For the past several years we have concentrated on treating the patients with tuberculous cavities by means of cavernostomy under the guidance of Professor Aoyagi, Assistant Professor Nagaishi, Kyoto University, and Dr. Yoshimura, head of the Hiraen National Sanatorium. During that period we have maintained that a cavernostomy, when combined with supplementary use of antibiotics and chemotherapeutics, and a preparatory performance of thoracoplasty, can secure the best safety. It has been our view that the thoracoplasty as a preparatory procedure for a cavernostomy was significant in three ways; namely when a thoracoplasty is performed,

- (1) the cavity shrinks to the minimum size; the draining bronchus is bent or obliterated to the maximum extent,
- (2) the inner wall of the cavity is cleaned; a stout protecting membrane forms on the wall of the cavity or in the surrounding lung parenchyma,
- (3) the surrounding lesion collapses and is put to rest.

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In the course of the studying of the significance of thoracoplasty as a preparatory procedure to a cavernostomy, we realized that we should determine to what extent a thoracoplasty best promises a safe performance of cavernostomy for a case with a given degree of the chest focus involvement. To answer this question, various cases differing in the number of times of costal resection and the length of the segment resected, have been studied with regard to such items as the degree of the chest collapse, amount of sputa, tubercle bacilli in sputa and finding of the interior of the cavity as inspected on the occasion of the cavernostomy carried out after the preparatory performance of thoracoplasty. The conclusion we gained was roughly as follows.

For a huge cavity thoracoplasty is needful either as a preparatory or as an additionally combined operation, particularly so when the draining bronchi are deemed to be wide open to the cavities. For a middle sized or minor cavity, however, cavernostomy alone suffices in some instances and never needs the thoracoplasty as the preparatory procedure. Not infrequently, due to a striking improvement of the surrounding lesions which was effected while the wound resultant from cavernostomy was under an open treatment institution of subsequent thoracoplasty needed a far smaller extent than previously contemplated.

Gaining these results which pleased us much, we have then proceeded to the trial of a treatment consisting in keeping open the chest sinus resulting from cavernostomy. This trial was performed on selected cases and brought forth a gratifying result, such as the cleaning and narrowing of cavity, disappearance or cirrhotic changes of the surrounding lesions. A not small number of cases were found to heal simply by this cavernostomy without resorting to a preparatorily or subsequently performed thoracoplasty.

Thence we tried a further step, treating patients with considerably spread caseous lesions as evidenced roentgenographically in spite of roentgenographic absence of a focus, by such a method as constructing a pit that points to the main lesion of the chest, and keeping the pit open thereafter thus exposing the affected lung tissues. This method proved more effective than we had first supposed.

Thus coming to believe that some types of the pulmonary tuberculosis can be cured simply by treating the main lesions in an open manner, we have decided to name this method tentatively the "Open Drainage of the Affected Lung Areas by Making a Surgically Constructed Pit", and studied further in detail its operative technique and indications. (Patients call this method "Tunnel Method.")

As to the difference between this method and Maurer's method, difficulty

in obtaining enough detailed informations on Maurer's method allows no precise comparison. However, they seem to differ distinctly in the following aspects:

While Maurer's method is an open method to treat the cavity, our method aims to treat both the cavity and the surrounding caseous lesions prior to the process of cavitation. Further, our method may be applied to any caseous lesions above a certain degree of size. For these reasons we wish to emphasize that these apparently resembling two methods are actually different considerably from each other.

Maurer's method and the open method of cavernostomy are both aiming at drainage of pus, and in this regard they do not differ from our method. However, a considerable difference should be noted in that the former two methods not only make the best use of the cavity wall as a protecting membrane but also help it get stouter, while our method attaches primary importance to the formation of a new protecting wall inside the lung, and only secondary importance to the preservation of a previously established protecting wall which this method dares to destroy when deemed necessary.

Beside this, so far as we know of Maurer's method, considerable differences seem to exist as to the operative technique, postoperative care and indications.

I. Operative Technique

(I) Preparation

Two things should be examined before a patient is operated upon by this method.

For one thing, it should be noted whether the pleura overlying the site selected for the establishment of the draining pit is adhesive. In case any free pleural space exists the operation should be performed after an adhesion is artificially induced. For artificially inducing a pleural adhesion, it was our practice either to inject 10 to 30 cc. of the patient's own blood plus penicillin once to thrice into the pleural cavity, or to expose first the parietal pleura then pack it by gauze and renew it daily for several days.

For another thing, attention should be paid to the precise localization of the main lesion. This caution is a matter of course, and not much needs be said about this.

(2) Preoperative Treatment

Before operating upon a case with exudative disease by this method, to administer the anti-tuberculous remedies for a certain period of time is naturally necessary. It is advisable, however, to begin the administration of anti-tuberculous remedies several days in advance of the operation to prevent the hematogenous or intracanalicular spread of the disease.

We found that the subcutaneous injection of Ringer's solution of blood transfusion as a preoperative treatment was in most cases unnecessary.

For inducing basal anesthesia, injections of 0.3 cc. of "Narcopon scopolamine" (4% morphine, 0.06% scopolamine) an hour before, and 0.3 cc. of the same half an hour before the operation, were found sufficient.

(3) Skin Incision and Extrapleural Pneumolysis

As to the skin incision, 5 to 10 cm. was the sufficient length, whether it be placed anteriorly, laterally or posteriorly. It was our practice to perform this under basal and local anesthesia, not a case being performed under general anesthesia.

The chest is then entered, avoiding as much as possible to cut muscles; 3 to 5 cm. segments of one or two ribs are resected when necessary. When pleura is exposed, it is first examined for the presence or absence of the free pleural space. In case the pleural adhesion is found complete the extrapleural pneumolysis is performed to such an extent as is enough for localizing the main lesion. We may encounter some cases in which pleura considered adhesive preoperatively proves to embrace a free space. It is possible in such a case to continue the operation by suturing a certain portion of the pulmonary pleura to the chest wall if the extent and condition of the free space permit, the suture separating the selected site from the rest of the free space.

However, for the sake of a better safety, the treatment should preferably be limited to the packing of gauze for the time being, further entry into the chest being postponed until the adhesion becomes complete.

(4) Identification of the Main Lesion

In order to localize the seat of a cavity, we use the following four means: inspection, palpation, compression test and the probing with a needle.

It will be ideal if fluoroscopy can be combined with these methods of localization.

Among the above four means of localization, palpation and compression-test are most commonly practiced and most sharply reveal the side of a cavity.

In case these methods of localization through pleura fail to identify the main lesion, it is of help to repeat searching after the lung is entered a little through the site determined roentgenographically as lying just above the lesion in question. The compression-test and the probing with a needle are often of no use when a cavity does not exist. In such cases the lung should be entered either by being led by the fluoroscopy, or by comparing the result of palpation with previously obtained roentgenographic views. When it so happened that all of these means failed to localize the main lesion, or that the pit established proved afterwards short of reaching the main lesion, it has been our practice to pour a certain amount of the 40 per cent iodized-oil into the established pit, localize the main lesion or the missed lesion by means of fluoroscopy or roentgenography, and then correct the pit track. By doing so we have achieved the purpose of the operation in almost all instances.

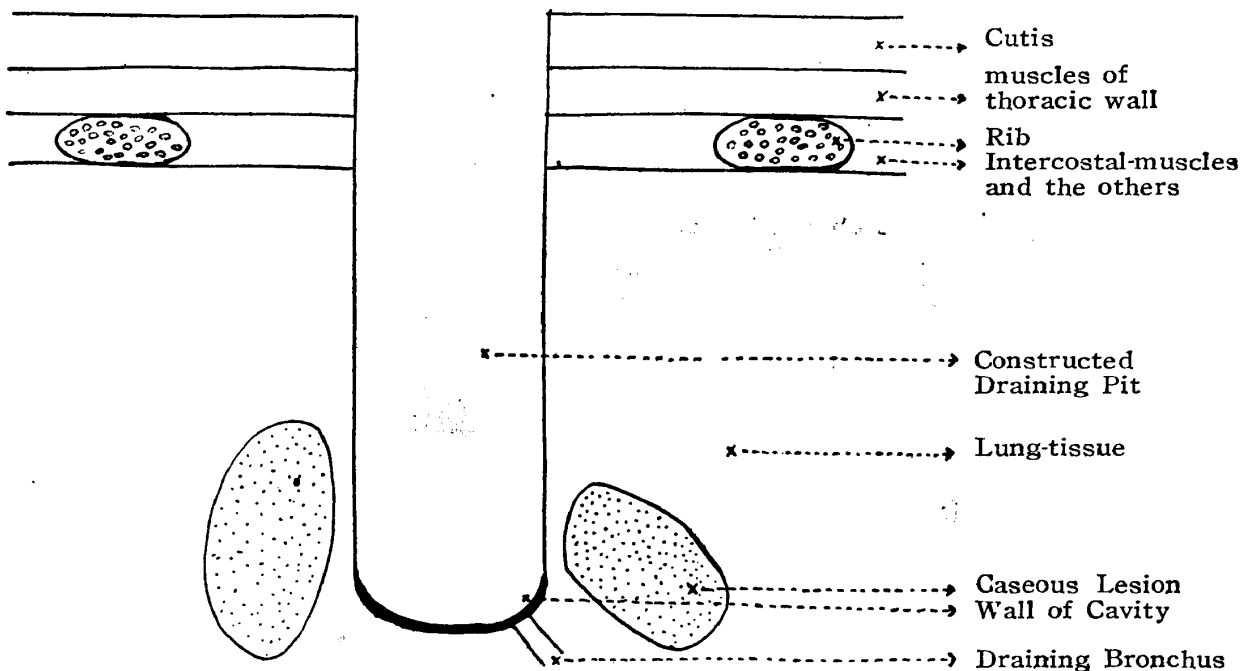
(5) Construction of the Draining Pit

The chest is entered after the main lesion is either localized transpleurally by such methods as stated above, or roughly localized on the basis of the previously obtained roentgenographic views.

As to the most adequate method of entering the lung, after having tried such

sharp instruments as a cautery knife as well as blunt ones like pincettes or Pean's forceps, we concluded that the finger-tip permits the bluntest and therefore the safest and the most certain entry at present. This is so because the pit track, only 2 to 5 cm. wide in diameter as is shown in the schematic illustration, hardly permits the visualization of the deep part during the operation, and in such a situation a blunt entry seems to be advantageous in that it runs smaller risk of doing harm to major vessels and bronchi or of going off the right way (Illustration). The shape of a thus constructed draining pit is shown above.

Illustration. The Model of Constructed Draining Pit in Our Operation



The ideal shape of a pit should be tunnel-like, with a wide cervix and a narrow bottom. We found it of absolute necessity for a draining pit to meet a condition that the bottom is as wide as the cervix. According to our experiences most of the cases failing to meet this condition did not attain the purpose of the operation, thereby necessitating subsequent thoracoplasty.

It is our opinion that if we have to contemplate establishment of a pit with such a wide cervix as exceeding 5 cm. in diameter, it is better to construct two pits from different directions. In case the cervical part of a pit track is narrowed either by the intercostal tissues or by the musculature of the chest wall, with resultant disturbance in visualization of the track and in renewing the gauze, a partial resection or retraction or suturing of these tissues is recommended.

When the construction of a pit is completed, the wound is either packed with jodoformium gauze or sprinkled with powder of chemotherapeutics, and then packed with dry simple gauze.

Injection of streptomycin or penicillin into the surrounding tissues of the pit, particularly subcutaneous tissues and muscles, is highly necessary.

For suturing lung tissues and others we usually use the silk thread without any

particular disadvantage.

Finally we wish to emphasize that the draining pit need not be made so reach the main lesion at once in one operation, that the construction of a pit may be suspended for several days keeping the wound open until the re-entry is attempted in the second operation. The leading principle in this operation is to avoid any forceful invasion.

II. Open Treatment in the Postoperative Course

The open treatment of the lesions in the postoperative course constitutes the most important part of this treatment. It is hardly an exaggeration to say that the treatment in this period and the selection of the indication determine whether or not this method is successful. The open treatment chiefly aims, first, at sufficient drainage of pus and exudate lining the pit wall and second, at drainage of pus from the caseous lesions around the pit.

In order to draining pus and exudate sufficiently, a particularly tight and snug packing of gauze should be obtained at the bottom part of the pit track, so that the blood and exudate lining the pit wall may not be drained through the draining bronchus into the bronchus and trachea. As to the means of obliterating a draining bronchus, after having tried silver nitrate, jodoformium, and electric cauterization, we came to use the 1 to 2 per cent solution of silver nitrate as a means of our choice. In some cases a draining bronchus remains wide open for one or two weeks in spite of the above methods of obliteration; these cases often necessitate thoracoplasty.

There is a report by a reviewer of this method that the application of this method to the cases with huge or cirrhotic cavities failed to produce a good result, and that he had to resort to a combined thoracoplasty. It should be emphasized, however, that these cases in question were of such a type of disease that becomes respondent to a thoracoplasty first by being operated upon by this method.

As for the gauze tamponade, Jodoformium gauze is exclusively used for several days following the operation. In this period antituberculous remedies should be administered generally, not locally. It is after bleeding subsides and exudation decreases that a tampon is replaced by simple gauze and anti-tuberculous remedies are sprinkled over the wound, the general administration being still continued. We opine that jodoformium gauze should preferably be replaced by simple gauze earlier than the first week's end, for a prolonged use of jodoformium gauze often causes headache, nausea and other side-actions of iodine.

It should be avoided to close the wound, leaving a considerable amount of caseous lesions around the draining pit. Closure of the pit should be contemplated only after the surrounding lesions within the assailable limits are treated through the pit and exposed sufficiently to the outer atmosphere. To expose the surrounding lesions it has been our practice to first repeat application of a very tight packing of gauze to the spot selected for the further entry to the lesion to be exposed, and then to enter the lesion by means of a pincers or a finger-tip. This entry should be attempted only after the pit wall overlying the lesion to be exposed is made sufficiently brittle in the course of the repetitive tamponade which takes usually one or two weeks. It

is wise to finish the construction of a pit thoroughly within one or two weeks because in later time the tissue of the pit wall granulates and becomes liable to bleeding or gets so hard that it prevents easy exchange of tampons packed in the freshly produced wound. When the wall of a pit is found to have undergone these disadvantageous changes, it is recommendable to construct another pit separately.

In short, the correction or extension of the pit track is most safely attempted when a pit is in such a condition that bleeding and exudation subside, and the wall is lined partly with soft granulation tissue, and partly with exposed lung tissue.

When a pit track is extended and a fresh wound is brought into existence, the same treatment as stated above is given to this part, after treating this part by tamponade with jodoformium gauze for a certain period of time.

As to the injection through the pit of anti-tuberculous remedies and other into the lung, which we have undertaken in some cases, we wish to make a separate report in the future.

III. Plombage of the Draining Pit Track with the Pedunculated Muscular Flap and the Later Care

When the tissue of the pit wall granulates sufficiently, a pedunculated muscular flap is sutured with the pit, thereby closing it. When the patient gives persistently positive result in the examination of the sputum, after closing the pit, we may contemplate the construction of another pit to drain the bacilliferous focus. We consider it of no use, at least of no effect upon the chest involvement, to continue the open treatment of the pit for an infinitely long time. Since the examination of the sputum for tubercle bacilli turns negative usually on the fifth postoperative day, the open treatment thereafter aims simply to improve the surrounding lesion and quicken the granulation. Because the granulation becomes sufficient usually in the 1st to 2nd postoperative month, closure of the pit is performed most often in this period.

As to plombage with the pedunculated muscular flap, not much need be said except that it should be carried out after the pit track is enlarged a little in the cervical part, since it is narrow and deep.

Owing to the fact that thoracoplasty is as a rule avoided in this method, we may encounter some cases in which a big dead space results in the subcutaneous layer from using too big a muscle graft for the plombage. For such instances it is of help to insert a drain subcutaneously within several days after the operation, and then fix it tightly by means of pressure bandage. In addition, the draining of the fluid by a needle and the injection of chemotherapeutics may be attempted if necessary.

After the pit is closed, the wound should be carefully attended until it undergoes a cicatricial healing sufficiently as evidenced by the color and hardness of the skin.

IV. Postoperative Course

(1) Body Temperature

Either after a pit is established or after it is closed, the temperature goes up to 100 F at the highest; however, it drops to the normal level within two to five days in

the former instances, and within one to two weeks in the latter instances.

(2) Urine

The cases operated upon by this method less frequently give the positive result for the urobilinogen test than those operated upon by cavernostomy or thoracoplasty.

(3) Body Weight

Those operated upon by this method show a faster recovery of body weight than those operated upon by cavernostomy or thoracoplasty. Most of the cases operated upon by this method recovered it by the end of the second postoperative month, and all cases exceeded their previous body weight in the later months; while a half of the cases operated upon by cavernostomy and thoracoplasty failed to recover the previous weight even after the 6th postoperative month.

(4) Blood Sedimentation Rate

The sedimentation rate goes up to the level of preoperative stadium usually in the 3rd postoperative month, then descends slowly till it comes to the normal level. In the cases showing a high rate preoperatively the sedimentation rate draws a slowly descending curve, while in the cases showing a low rate preoperatively the curve is such that it goes up once, and then descends.

When it is recalled that cavernostomy and thoracoplasty permit only a half of the cases operated upon to obtain the normal rate in the 6th postoperative month, it may be safely asserted that this method brings about a quicker recovery than cavernostomy or thoracoplasty. Reference to the result of other colloidal tests also supports this view.

(5) Vital Capacity

It will be naturally imagined that this method causes a less decrease and a quicker recovery of the vital capacity than cavernostomy or thoracoplasty. This has been proved by the results of various tests of the lung function.

(6) Amount of the Sputum

Reference to Table I. will reveal that this method is in general far superior to thoracoplasty, but a little inferior to cavernostomy in its effect to bring about reduction in the amount of sputum. The bloody sputum disappears usually within a week. However, owing to the character of this method as an open method, it may last longer than in the case of cavernostomy (Table I).

Table 1 Types of Expectoration after Operations

type \	cavernostomy	thoracoplasty	our method
I	16	7	14 (8)
II	5	8	6 (1)
III	1	7	3 (1)
IV	0	2	7 (4)
V	3	1	16 (8)
total	25	25	46 (22)

(Note):

Type I: Expectoration stops within a few days following the operation, and persists so since then.

Type II: Expectoration subsides gradually till it stops.

Type III: Expectoration subsides once, but regains the previous amount.

Type IV: Considerable expectoration persists in spite of the operation.

Type V: No expectoration ever.

(Note):

Values presented in the columns for cavernostomy and thoracoplasty indicate the results of follows up exceeding 6 months. Values in parentheses indicate the results of follows up over 3 months and () indicate the results of follows up exceeding 6 months.

(7) Fluctuation of Tubercle Bacilli in the Sputum

Examinations of the sputum for tubercle bacilli, as shown in Table 2, give negative result (in repeated concentration tests) in all cases in the first to second month after the draining pit is constructed, give negative result (in repeated culture tests) in 6 cases whose pits are closed. Two cases belonging to Type IV in Table 2, however, reveal the existence of a cavity or tuberculous lesion on the same side or opposite side of the chest, and are going to be operated upon by this method again (Table 2 (A) Table 2 (B))

Table 2 (A) Tubercle Bacilli in the Sputum after Operation

	repeated smear		repeated culture	
	(+)	(-)	(+)	(-)
preoperation	16	4	21	5
over 3 month	4	16	0	4*
over 6 month	0	0	3*	19*

(Note):

The mark (*) indicates the patients having had pits closed.

Repeated culture tests were carried out only on these cases.

Table 2 (B) Fluctuation of Bacilli in the Sputum

type	cavernostomy	thoracoplasty	our method
I	2	1	10 (2)
II	18	13	19 (9)
III	1	2	3 (2)
IV	2	3	7 (6)
V	1	2	3 (0)
VI	1	4	4 (3)
total	25	25	46 (22)

(Note):

Type I: Tubercle bacilli in the sputum can not be found ever.

Type II: Tubercle bacilli can not be found within a month following the operation, and persists so since then.

Type III: Tubercle bacilli subside gradually till it can not be found.

Type IV: Tubercle bacilli subside once, but regain the previous value, and once more subsides till it cannot be found.

Type V: Considerable value persists in spite of the operation.

Type VI: Tubercle bacilli subside once, but regains the previous value.

(8) Tubercle Bacilli in the Blood

Examining for times intermittently blood of 6 cases operated upon by this method during the period of 7 days following the operations, we have seen not a case reveals the tubercle bacilli in the blood. Just as we have learned from our experience with cavernostomy, the hematogenous spread of the pulmonary tuberculosis seems to happen very rarely when anti-tuberculous remedies are being administered. No sign of the hematogenous spread was seen in 4 cases in and after the 6 month in their postoperative course.

(9) Roentgenographic Findings

The roentgenographic findings of the patients with closed pits were that the surrounding infiltrations turned a focus of solid linear shadows while the muscle plung indicated the previous site of the main lesion. The disease was judged to be getting better.

To summarize, it is in the first to second postoperative month that the pit wall becomes clean and the granulation attains a sufficient proliferation to permit the closure; the disease subsides in the 3rd postoperative month; the patients in many instances may be engaged in light works after the 6th postoperative month.

Although this report does not deal with it, the result of the liver function tests has also supported the above estimation of the postoperative course.

We have encountered no instance of any complication. This is probably due to

the sufficient precaution we have taken for treatment as we have learned from our experience with cavernostomy.

V. Limitations of this Method from Morbid-Anatomical View-Point

Among 46 cases operated upon by this method, a histopathologic investigation has been performed in 11 cases, and autopsy in one case. The following report deals with the healing process produced by the open treatment of the tuberculous lesion and the histopathologic change that occurs in the surrounding tuberculous lesions and the lung parenchyma adjacent to the pit. The specimens were obtained by Grünwald's forceps from the pit wall during the operation and at different times in the course of the postoperative stadium; namely, the 2nd specimen was obtained in the 1st to 2nd postoperative week when bleeding mostly subsides and exudation ceases; the 3rd specimen in the 3rd to 5th postoperative week; the 4th specimen immediately before the closure of the pit by the pedicle muscle graft.

To obtain a specimen of the tissue deep in the lung through the pit wall, the VIM biopsy needle was employed.

As to staining, hematoxylin-eosin staining, van Gieson's staining, Watanabe's silver staining and other methods to stain the tubercle bacilli have been used.

The specimen obtained upon the initial exposure of the lesions and construction of the pit, revealed a typical picture of the productive form of tuberculous affection in most cases except in two patients where the round cell infiltration was the predominant picture and no giant-cell nor epithelioid cell infiltration was found at all. The histopathologic investigation of the pit wall in the course of the open treatment revealed such views as the following: the increasing infiltration of polynuclear leukocytes and round cells and dilated or proliferating capillaries characterized the picture of the 1st to 2nd postoperative week; a marked degree of capillary dilatation or proliferation and a decrease of polynuclear leukocytes were prominent pictures of the 3rd to 5th postoperative week. After this period the collagen fibers were found to proliferate among the round cells.

Tubercles were scarcely observed. The epithelioid cells were often covered by the round cell infiltration. The picture of the 7th postoperative week resembled that of the 3rd to 5th week.

By a biopsy needle we could observe the changes occurring in the tissue within 3 cm. in depth from the pit wall. Not very deep from the wall, lung parenchyma was first found in the same condition with the wall, but in the course of time became prominent in its picture of collagen fibers proliferation stretched out from the pit wall as the open treatment advanced.

Remotest from the pit wall, the alveoles were found free of exudate, although a large number of round cells were prominent.

The above findings coincided with the findings obtained at the autopsy of one case. The results of basic experiments performed on rabbits also coincided with them.

The above facts may be recapitulated histopathologically as follows:

(I) The changes brought about by the open treatment in the tuberculous lesions are such that the specific inflammatory process subsides, and a non-specific, acute inflammatory process becomes prominent with a marked proliferation of granulation tissue.

This reveals the cicatricial healing of the tuberculous lesions.

(2) Lung parenchyma around the pit, particularly the tuberculous lesions lying at depth of 3cm. from the pit wall, undergo a cirrhotic change caused by the mild stimulus produced by the open treatment.

The open treatment by constructing draining pit has proved of effect to the surrounding lung parenchyma, particularly to the tuberculous lesions, although with a reservation that a lesion in a certain degree of conglomeration lying at a depth exceeding 3 cm. from the pit wall escapes the cicatricial healing, even though it may be brought to a productive cirrhotic state by the open treatment. The co-existence of a main lesion side by side with such an adjacent lesion as the aforementioned, may indicate the advisability of the construction of two pits established either separately or in a form of a pit giving rise to a branch at a certain spot. There are some cases where the construction of a pit should better be contemplated after the performance of a pneumolysis so that the lesion may shrink prior to the construction.

VI. Indications for Characteristics of This Method

Our experience with this method in 46 cases (Table 3) has induced us to recognize indications for this method in such types of cases as shown in Table 4.

For such a case as likely to fall between A-(2) and B-(1) of Table 4, combination of this method and pneumolysis secures an excellent result.

Since this method owes its practicability to the recent appearance of excellent antituberculous remedies, it is expected that the future advance in the field of antituberculous remedies will expand the indications for this method and secure better results within a shorter duration of the treatment.

This method is characterized by such features as shown in Table 5. This method with its mild degree of surgical invasion is easily combined with other method of the collapse therapy, and the collapse therapy, in

return, is made to attain its purpose throughly by the preceding institution of this method.

Table 3 Our Operative Cases

unilateral	lesion presented only upper field	cavity	presented	12	17
			no presented	5	
	lesion presented not only upper but middle field	cavity	presented	11	13
			no presented	2	
bilateral	lesion presented bilateral, and cavities presented in unilateral			11	16
	cavities presented in bilateral sides			5	

Table 4 Indication

- (A) This method alone suffices for following types of disease:
- (1) Disease limited to one or two bronchial segments without or with cavities of small size.
 - (2) Disease spread over two or three bronchial segments with outstanding main lesion at the center.
- (B) Combination with some other surgical method is necessary in following types of disease:
- (1) Diseased lung dotted with some number of advanced foci on which no collapse therapy seems to work.
 - (2) Bilateral disease of a patient incapable of bearing an extensive operation.

Table 5 Characteristic Features of This Method

- (1) Because of the mild degree of the operative invasion, repeated reoperation is possible.
- (2) This method promotes the cicatricial healing of the lesion.
- (3) This method does not cause a serious deformity of the chest.
- (4) This method may be combined with other surgical operations.

Summary

An open treatment of the tuberculous cavities and caseous lesions prior to the cavitation process as a surgical therapy for some types of the pul-

monary tuberculosis has been established. We have named this method tentatively "The open treatment of the caseous tuberculous lesions by surgically constructing draining pits".

The operative technique and indications have been reported in this papers.

Although real value of this method should be estimated on the basis of the results of longer follows-up, the results up to date are better than we first supposed. The author wishes this report will call attention of those concerned to the study of this subject.

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